

LA-UR-20-28900

Approved for public release; distribution is unlimited.

Title: (U) Jezebel Densities and Uncertainties

Author(s): Favorite, Jeffrey A.

Intended for: Report

Issued: 2020-11-02

Disclaimer:

Los Alamos National Laboratory, an affirmative action/equal opportunity employer, is operated by Triad National Security, LLC for the National Nuclear Security Administration of U.S. Department of Energy under contract 89233218CNA000001. By approving this article, the publisher recognizes that the U.S. Government retains nonexclusive, royalty-free license to publish or reproduce the published form of this contribution, or to allow others to do so, for U.S. Government purposes. Los Alamos National Laboratory requests that the publisher identify this article as work performed under the auspices of the U.S. Department of Energy. Los Alamos National Laboratory strongly supports academic freedom and a researcher's right to publish; as an institution, however, the Laboratory does not endorse the viewpoint of a publication or guarantee its technical correctness.

X-Computational Physics Division
Radiation Transport Applications Group
Group XCP-7, MS F663
Los Alamos, New Mexico 87545
505/667-1920

To/MS: Distribution
From/MS: Jeffrey A. Favorite / XCP-7, MS F663
Phone/Email: 7-7941 / fave@lanl.gov
Symbol: XCP-7:20-032(U) (LA-UR-20-?????)
Date: October 28, 2020

SUBJECT: (U) Jezebel Densities and Uncertainties

The ^{239}Pu Jezebel benchmark¹ is a keystone for plutonium nuclear data evaluation. At a recent presentation at a nuclear data workshop, Morgan White (LANL P-27) presented a slide about the Jezebel plutonium-alloy part densities and their uncertainties.² White's slide is shown in Figure 1. There are two major errors and one opinion presented as fact.

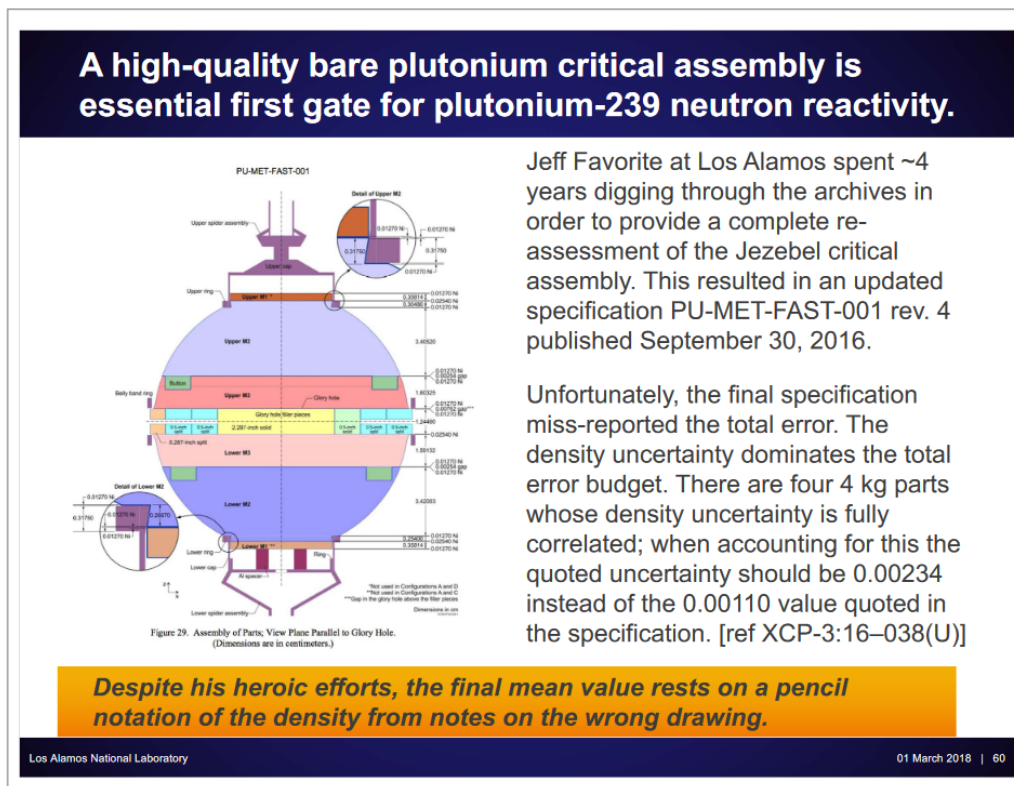


Figure 1. Slide from Ref. 2.

Error #1. "...[W]hen accounting for this [the opinion that the four 4-kg parts are fully correlated] the quoted uncertainty should be 0.00234 instead of the 0.00110 value quoted in the specification."

Correction. Table I of Ref. 3 (the report referenced on the slide) is reproduced as Table I below, where $\delta k_{eff}/k_{eff,0}$ is the relative uncertainty in k_{eff} and u_{ρ}/ρ_0 is the relative uncertainty in the density. If the relative uncertainty in the density is $\pm 0.2\%$, as the experimenters stated,⁴ and the four 4-kg parts are uncorrelated, then the total experimental uncertainty is ± 0.00110 , as given in the evaluation. If the parts are fully correlated, then the total experimental uncertainty is ± 0.00169 , not ± 0.00234 . If the experimenters underestimated the density uncertainty by a factor of two and, in addition, the parts are fully correlated, then the uncertainty in k_{eff} due to mass, dimensions, and density is ± 0.00234 .

Table I. $\delta k_{eff}/k_{eff,0}$ for Different Assumptions

u_{ρ}/ρ_0	Part Correlation	$\delta k_{eff}/k_{eff,0}$ Due to Mass, Dimensions, and Density	Total $\delta k_{eff}/k_{eff,0}$
$\pm 0.2\%$	None	$\pm 0.00057^{(a)}$	$\pm 0.00110^{(a)}$
$\pm 0.2\%$	Full	$\pm 0.00117^{(a)}$	$\pm 0.00169^{(a)}$
$\pm 0.4\%$	None	± 0.00114	± 0.00145
$\pm 0.4\%$	Full	± 0.00234	± 0.00250

(a) Ref. 1, Table 41.

Error #2. "...[T]he final mean value rests on a pencil notation of the density from notes on the wrong drawing."

Correction. The densities of the four major parts were obtained from the as-built drawings.⁵ The drawings were transmitted to Hugh Paxton in 1954 under a memo that said, "Attached are summary data sheets and dimensioned drawings of Jezebel components."^{5,6} These drawings, shown in Figures 2 through 5, give the measured density of each of the four major parts. The pencil notations on the as-built drawings apparently refer to a subsequent ²³³U Jezebel. These drawings are not the wrong drawings for ²³⁹Pu Jezebel, and the pencil notations were not used in the ²³⁹Pu Jezebel evaluation.

Opinion. "There are four 4 kg parts whose density uncertainty is fully correlated...."

Correction. It is likely that the four 4-kg parts are correlated at some level. It is mere opinion that they are fully correlated, and this statement should not be presented as or accepted as fact.

At the end of the talk (Ref. 2, slide 63), White advocates for a new bare, critical plutonium assembly. I support such an experiment. However, let us argue for it without distorting the state of our present knowledge.

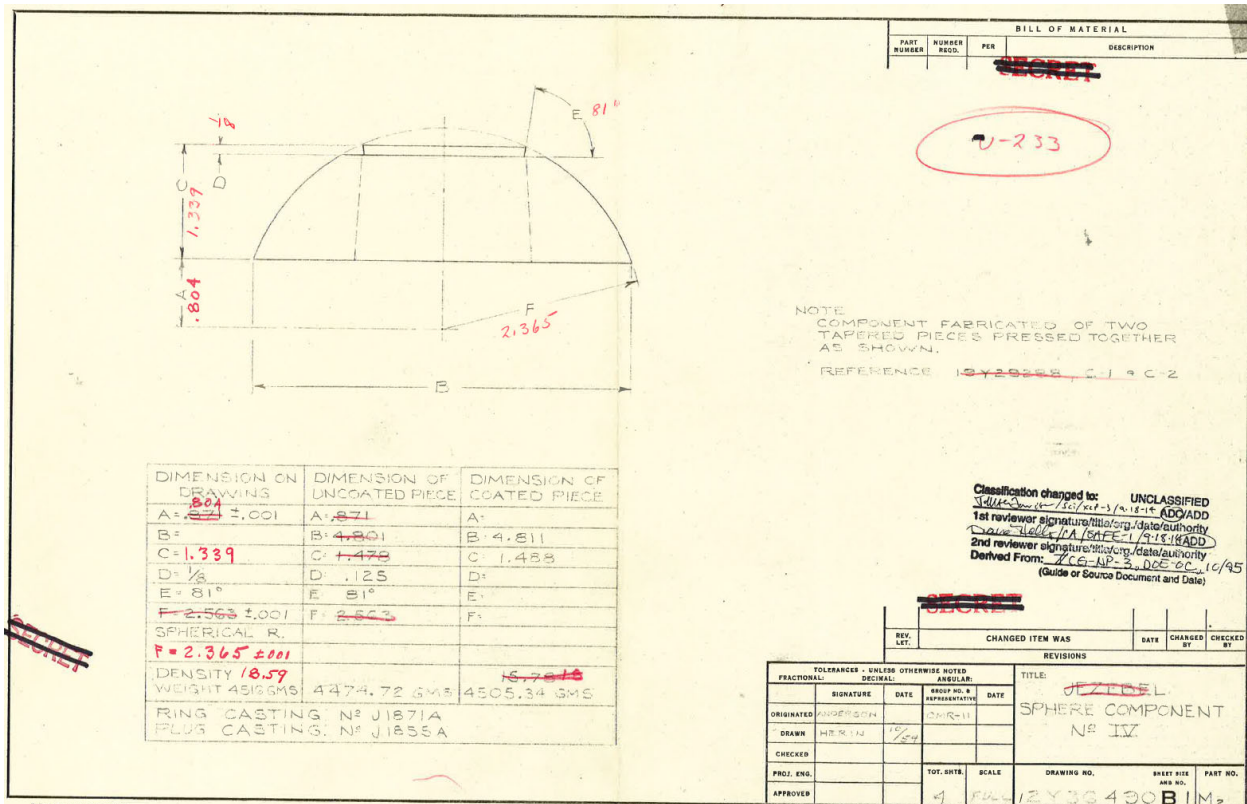


Figure 2. "Jezebel Sphere Component No. IV," Drawing 12Y36490 B1, October 1954.

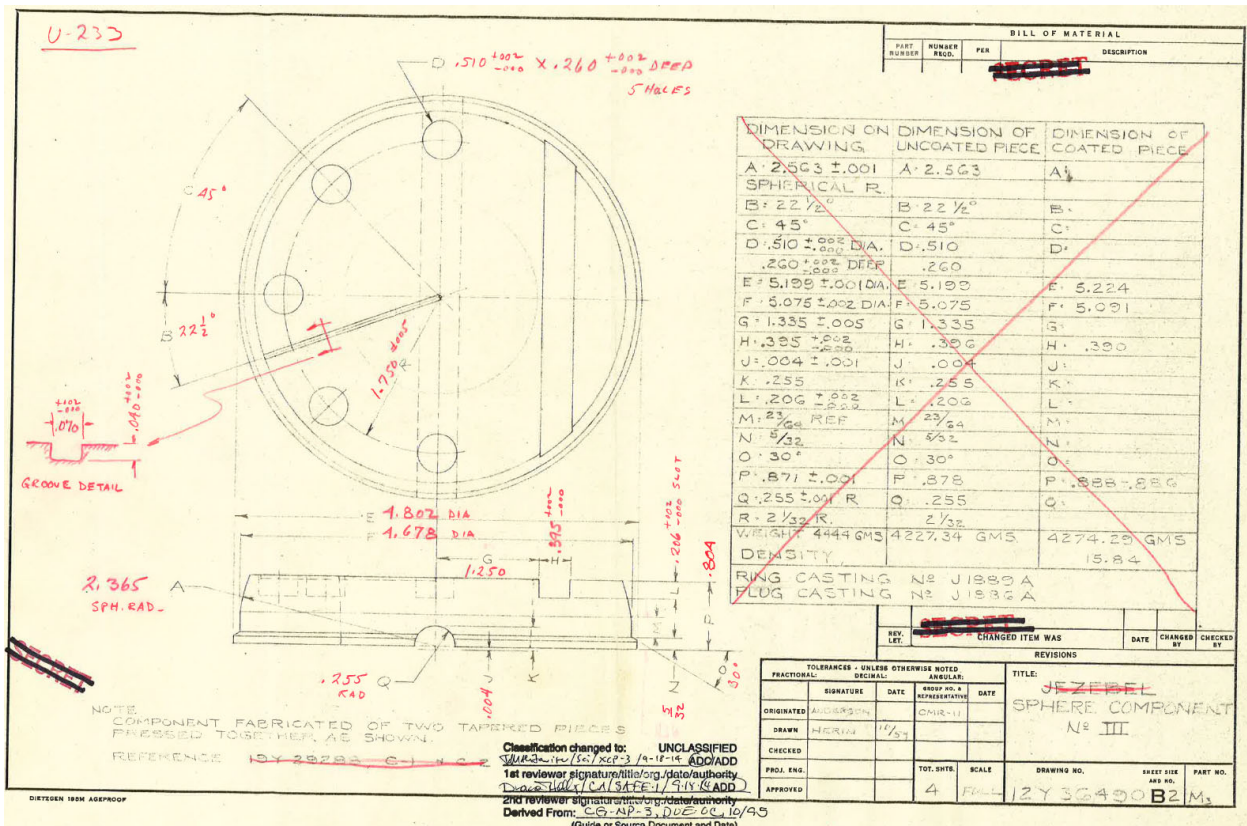


Figure 3. "Jezebel Sphere Component No. III," Drawing 12Y36490 B2, October 1954.

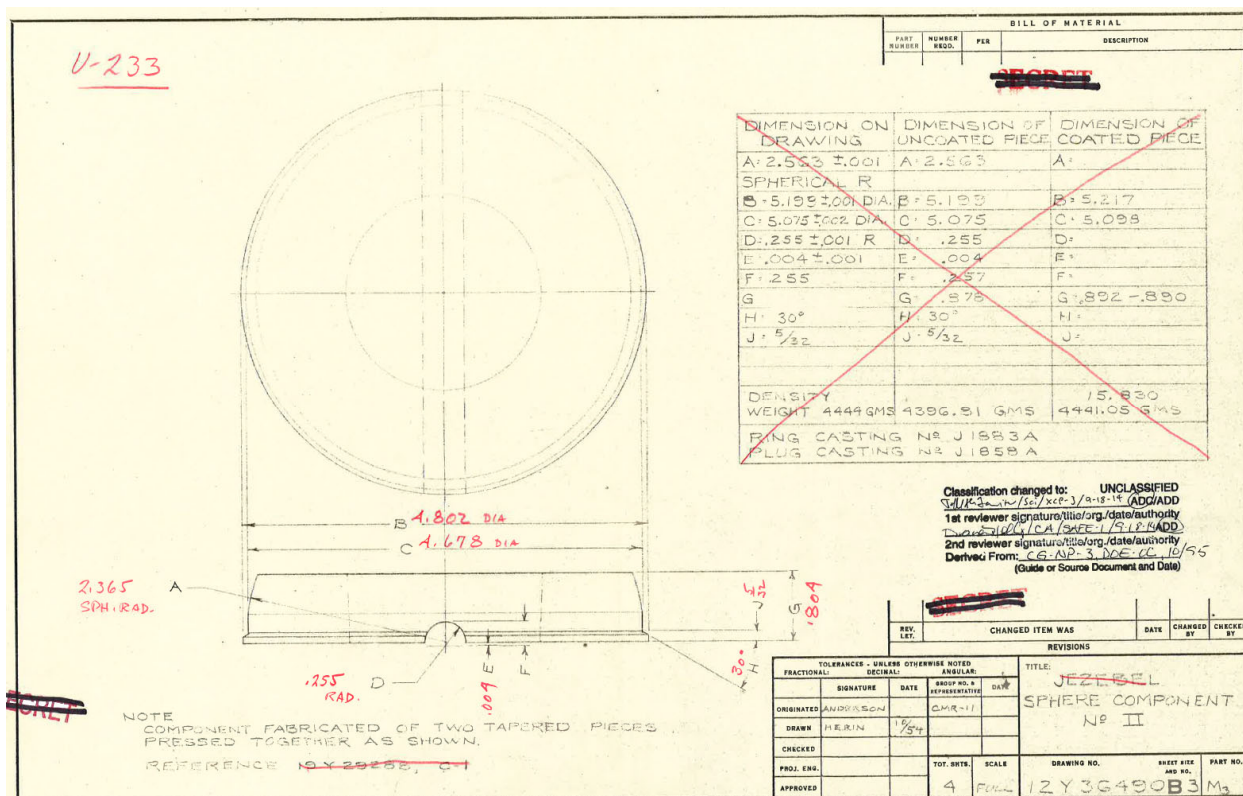


Figure 4. "Jezebel Sphere Component No. II," Drawing 12Y36490 B3, October 1954.

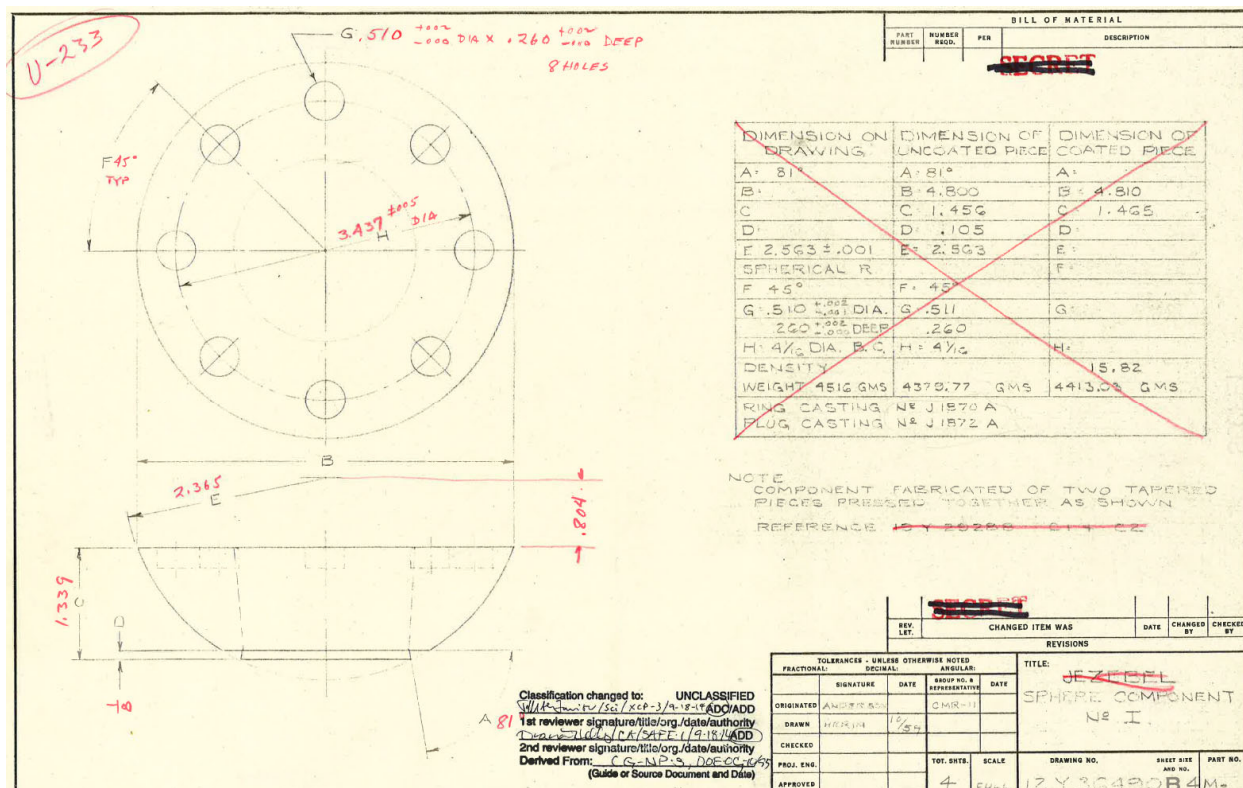


Figure 5. "Jezebel Sphere Component No. I," Drawing 12Y36490 B4, October 1954.

References

1. Jeffrey A. Favorite, Roger W. Brewer, and Michael Zerkle, "Bare Sphere of Plutonium-239 Metal (4.5 at.% ^{240}Pu , 1.02 wt.% Ga)," *International Handbook of Evaluated Criticality Safety Benchmark Experiments*, PU-MET-FAST-001, Revision 4, Nuclear Energy Agency, Organization for Economic Co-Operation and Development (December 2016).
2. Morgan C. White, "Caveat Emptor! Uncertainties are Uncertain: Changes in ENDF/B-VIII.0 Uncertainties to Reproduce Issues in Underlying Measurements and Theory," 9th TriLab Nuclear Data Workshop (NDW9), Los Alamos, New Mexico, Feb. 26–March 2, 2018; <https://doi.org/10.2172/1427371>.
3. Jeffrey A. Favorite, "(U) Effect of Large Correlated Density Perturbations in Jezebel," Los Alamos National Laboratory report XCP-3:16-038(U), June 27, 2016.
4. G. E. Hansen and H. C. Paxton, "Reevaluated Critical Specifications of Some Los Alamos Fast-Neutron Systems," Los Alamos Scientific Laboratory report LA-4208, September 1969.
5. Jeffrey A. Favorite, "(U) Archive of Historic Pu-239 Jezebel Documents," Los Alamos National Laboratory report LA-UR-16-23760, May 16, 2016.
6. W. B. Gibson, "Jezebel," Los Alamos National Laboratory report LAB CMR-11-1850, October 28, 1954.

JAF:jaf

Distribution:

J. T. Goorley, XCP-7, MS A143, jgoorley@lanl.gov
M. B. Chadwick, ALDX, MS A109, mbchadwick@lanl.gov
R. C. Little, XCP-DO, MS F663, rcl@lanl.gov
M. C. White, P-27, MS H807, morgan@lanl.gov
J. M. Goda, NEN-2, MS B228, jgoda@lanl.gov
J. L. Conlin, XCP-5, MS F663, jlconlin@lanl.gov
W. Haeck, XCP-5, MS P365, wim@lanl.gov
D. Neudecker, XCP-5, MS P365, dneudecker@lanl.gov
D. K. Parsons, XCP-5, MS F663, dkp@lanl.gov
C. S. Plesko, XCP-5, MS A143, plesko@lanl.gov
P. Talou, XCP-5, MS F644, talou@lanl.gov
J. A. Favorite, XCP-7, MS F663, fave@lanl.gov
National Security Research Center, nsrc-cataloging@lanl.gov
XCP-7 File